|  |  |
| --- | --- |
| ***Type*** | ***Units*** |
| **R1** | **7** |
| **R2** | **6** |
| **R3** | **9** |
| **R4** | **3** |
| **R5** | **8** |

Banker’s Algorithm Example – Discussion 4

7 Processes

5 Resource types

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** | ***(Available)*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** | *(7,5,7,3,7)* |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** | *(6,5,6,3,7)* |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** | *(6,4,6,3,5)* |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** | *(4,3,6,3,4)* |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** | *(4,1,6,3,4)* |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** | *(2,0,6,2,4)* |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** | *(1,0,2,2,4)* |

Total allocated: *(6,6,7,1,4) of (7,6,9,3,8) leaving available resources: (1,0,2,2,4)*

Which process can we satisfy with available resources? P2 is the only viable option.

**P2** :

Max claim = (2,0,3,2,1)

Allocated = (1,0,1,0,0)

Needs = (1,0,2,2,1)

Available = (1,0,2,2,4)

P2 acquires (1,0,2,2,1) + Allocated (1,0,1,0,0) => (2,0,3,2,1) = Max claim

After P2 processes, (2,0,3,2,1) released

**<P2, …>**

**Available** = Previous Available (1,0,2,2,4) + P2 Allocated before (1,0,1,0,0) = ***(2,0,3,2,4)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Next only possible option is **P6**:

Max claim = (4,1,3,2,2)

Allocated = (2,1,0,1,0)

Needs = (2,0,3,1,2)

Available = (2,0,3,2,4)

After P6 finishes, releases (4,1,3,2,2)

**<P2,P6,…>**

***Available*** *= (2,1,0,1,0) + (2,0,3,2,4) =* ***(4,1,3,3,4)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Next is **P7**.

Max claim = (1,1,6,0,0)

Allocated = (1,0,4,0,0)

Needs = (0,1,2,0,0)

Available = (4,1,3,3,4)

After P7 finishes, releases (1,1,6,0,0)

**<P2, P6, P7, …>**

***Available*** *= (1,0,4,0,0) + (4,1,3,3,4) =* ***(5,1,7,3,4)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Next is **P4**

Max claim = (5,2,4,0,5)

Allocated = (2,1,0,0,1)

Needs = (3,1,4,0,4)

Available = (5,1,7,3,4)

After P4 finishes, releases (5,2,4,0,5)

**<P2, P6, P7, P4, …>**

***Available*** *= (2,1,0,0,1) + (5,1,7,3,4) =* ***(7, 2, 7, 3, 5)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Next is **P1**

Max claim = (6,2,5,0,2)

Allocated = (0,1,2,0,1)

Needs = (6,1,3,0,1)

Available = (7,2,7,3,5)

After P1 finishes, releases (6,2,5,0,2)

**<P2, P6, P7, P4, P1, …>**

***Available*** *= (0,1,2,0,1) + (7,2,7,3,5) =* ***(7,3,9,3,6)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Next is **P3**

Max claim = (7,4,0,1,8)

Allocated = (0,1,0,0,2)

Needs = (7,3,0,1,6)

Available = (7,3,9,3,6)

After P3 finishes, releases (7,4,0,1,8)

**<P2, P6, P7, P4, P1, P3, …>**

***Available*** *= (0,1,0,0,2) + (7,3,9,3,6) =* ***(7,4,9,3,8)***

|  |  |  |  |
| --- | --- | --- | --- |
| ***Process*** | ***Max Claim*** | ***Allocation*** | ***Need*** |
| **P1** | **(6,2,5,0,2)** | **(0,1,2,0,1)** | **(6,1,3,0,1)** |
| **P2** | **(2,0,3,2,1)** | **(1,0,1,0,0)** | **(1,0,2,2,1)** |
| **P3** | **(7,4,0,1,8)** | **(0,1,0,0,2)** | **(7,3,0,1,6)** |
| **P4** | **(5,2,4,0,5)** | **(2,1,0,0,1)** | **(3,1,4,0,4)** |
| **P5** | **(1,6,2,1,4)** | **(0,2,0,0,0)** | **(1,4,2,1,4)** |
| **P6** | **(4,1,3,2,2)** | **(2,1,0,1,0)** | **(2,0,3,1,2)** |
| **P7** | **(1,1,6,0,0)** | **(1,0,4,0,0)** | **(0,1,2,0,0)** |

Only process left is **P5**. We finally have enough resources to cover this process’ max claim.

Max claim = (1,6,2,1,4)

Allocated = (0,2,0,0,0)

Needs = (1,4,2,1,4)

Available = (7,4,9,3,8)

After P5 finishes, releases (1,6,2,1,4)

Double check to make sure we have same amount of resources as we started with…

Original Available resources = (7,6,9,3,8)

Available resources = (0,2,0,0,0) + (7,4,9,3,8) = (7,6,9,3,8)

***FINAL ORDER: <P2, P6, P7, P4, P1, P3, P5>***